

U. S. NUCLEAR REGULATORY COMMISSION

REGION III

Report No. 50-483/92016(DRS)

Docket No. 50-483

License No. NPF-30

Licensee: Union Electric Company  
Post Office Box 149 - Mail Code 400  
St. Louis, MO 63166

Facility Name: Callaway Nuclear Plant

Inspection At: Callaway Site, Steedman, MO 65077

Inspection Conducted: September 14-18, 1992

Inspector:

Isa T. Yin  
Isa T. Yin

10/1/92  
Date

Jay A. Lennartz  
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10/1/92  
Date

Approved By:

Bruce L. Burgess  
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Operational Programs Section

10/1/92  
Date

Inspection Summary

Inspection on September 14-18, 1992 (Report No. 50-483/92016(DRS))

Areas Inspected: Special, announced, inspection of licensee followup of water hammer events that occurred in the RHR and ESW safety related piping systems. The inspection was based on NRC Inspection Procedure 92720.

Results: Licensee corrective actions related to ESW and RHR water hammer events was considered to be adequate. Corrective actions included documentation of the event, walkdown of the piping to assess damage, determination of the most likely root cause, and initiation of corrective actions.

## DETAILS

### 1. Persons Contacted

#### Union Electric Company (UE)

- \*G. Randolph, Vice President, Nuclear Operation
- \*J. Blosser, Plant Manager
- \*C. Naslund, Manager, Nuclear Engineering
- \*J. V. Laux, QA Manager
- \*R. Affolter, Superintendent, Design Control
- \*J. A. McGraw, Superintendent, Systems Engineering
- \*C. Pilkington, Outage Supervising Engineer
- \*D. Bettenhausen, Supervising Engineer
- \*C. Slizewski, Supervising Engineer, QA
- \*R. Lamb, Shift Supervisor
- \*T. DeVincentis, Design Engineer
- \*D. Maxwell, Design Engineer
- \*F. W. Eggers, Senior Engineer, QA
- \*S. Petzel, Engineer, QA

#### U. S. Nuclear Regulatory Commission

- \*L. R. Greger, Branch Chief, DRP
- \*B. L. Bartlett, Senior Resident Inspector
- \*D. Calhoun, Resident Inspector

\*Indicates those attending the exit meeting at the site on September 18, 1992.

Other licensee personnel were contacted as a matter of routine during the inspection.

### 2. Introduction

This inspection was conducted to assess the licensee's actions in response to the water hammer events that occurred in the essential service water (ESW) system. During the inspection, the licensee records showed similar events occurred in other safety related systems, such as residual heat removal (RHR), safety injection accumulator, and chemical and volume control charging. The inspectors expanded the scope to include RHR water hammers as a part of the overall assessment of the licensee actions. The chemical and volume control system and the safety injection accumulator system were evaluated for water hammer events and based on the low frequency were not considered during this inspection.

3. ESW Water Hammer Events

Between April 1986 and January 1987, damage to pipe clamp, sway strut, and containment cooler brazed joint connections was identified during and shortly after the first plant refueling outage (RF-1). In March 1987, the licensee staff suspected that the damage to the containment coolers was caused by water hammer, and recommended installation of surge arrestors, relief valves on the coolers, and the addition of pipe supports or a similar modification to mitigate water hammer damage. The licensee's engineering department concluded that the water hammer event was a result of inadequate filling and venting of the ESW system. Vent valves were installed in October 1987 in response to the licensee's conclusion regarding root cause.

In October 1990, during Refueling No. 4 (RF-4), a water hammer event caused damage to three snubbers, and three ESW pipe clamps in close proximity to the damage that occurred in 1987. Root cause analysis by the licensee determined the event was caused by improper filling and venting of the ESW system. Corrective action taken was to improve the written instructions for the filling and venting of the ESW system.

In November 1990, during RF-4, another water hammer event occurred due to a deficient post maintenance test procedure after maintenance on the service water (SW) to ESW cross tie valve. During stroking of the valve, a substantial amount of water in the ESW line was drained into the SW line. The remaining void caused a water hammer during the starting of the ESW pumps. Licensee corrective action involved providing additional guidance in the written instructions for filling and venting the ESW system. Again, the cause of the event was attributed to inadequate filling and venting of the ESW system subsequent to performing maintenance.

In March 1992, during RF-5, a water hammer damaged one snubber, four pipe clamps, two sway struts, and one spherical ball bushing on a pipe support during an engineered safety features actuation system (ESFAS) test. The cause of the problem was again attributed to a water hammer event subsequent to the drain down of the SW system for a maintenance activity.

In April 1992, while still in RF-5, no water hammer events occurred when the licensee returned the ESW system back into service. The lack of water hammer events was attributed to the operation procedure upgrade conducted during RF-4.

In June 1992, the licensee's engineering department verified the cause of the March 1992 event to be separation of the ESW pump discharge water column. Short term corrective actions involving procedural changes to operating and surveillance procedures were developed and implemented in August 1992. Proposals for long term fixes will be determined by November 1992 and will be based on a decision regarding elimination of the cause of the water hammer problem, or to provide additional piping restraints to withstand the force of the water hammer events. Design and engineering for the long term fixes was scheduled to be completed in the first quarter of 1993. The actual system modification was planned to be conducted during RF-6 in Fall of 1993. The licensee also planned to revise the ESFAS system test procedure before RF-6 to prevent water column separation.

4. Residual Heat Removal (RHR) Water Hammer Events

In January 1990, the Wolf Creek Nuclear Plant informed Callaway about specific snubber failures in the RHR system. Callaway inspected train A of the RHR system and identified a failure of two small mechanical snubbers. In addition, one small snubber was found failed on train B. Prior to this, there had been no reportable events, and no signs of physical damage to the RHR system. The licensee determined the cause to be inadequate system fill and vent, and made appropriate procedural changes.

In December 1990, a water hammer event occurred in the B train. The licensee walkdown identified minor damage indications such as pipe insulation slippage. The cause was determined to be due to minor check valve leakage. The total leakage was 0.3 gpm among the 17 check valves; the worst (CV 8818D) on train B had a leak rate of 0.2 gpm. The leakage was within the Technical Specification (TS) limit. A work request was written to repair the leaking check valves during RF-5, in the spring of 1992.

In January 1992, water hammer in the RHR "B" train occurred again. The total check valve leakage had increased to 1.2 gpm; the worst individual check valve leakage measured 0.8 gpm. A system walkdown by the licensee did not identify any damage. As an interim measure, the licensee installed relief valves on the safety injection test lines to relieve RHR system back pressure caused by check valve leakage.

In April 1992, during RF-5, the licensee repaired seven check valves and measured total check valve leakage at 0.03 gpm. A failed small snubber found on train B was

replaced with a rigid strut. The snubber inspection had been delayed by 3 months due to radiation considerations, however, the inspection had been conducted within the Technical Specification six month allowance.

5. ESW Operation

a. Operating Procedure

The inspectors reviewed the normal operating procedure, OTN-EF-00001, essential service water system, revised as part of the licensee's corrective actions for the October 1990 and November 1990 water hammer events. The revisions were made to improve the fill and vent portion of the procedure. The changes made in response to the October 1990 event were not adequate as evidenced by the occurrence of the November 1990 event. After review of the revisions made in response to the November 1990 event, the NRC concluded that the changes were adequately supported by the fact that the licensee had not experienced a water hammer event during fill and vent operations of the ESW system during RF-5.

The NRC determined that another aspect to prevent water hammer events included plant personnel and operator knowledge. The inspectors concluded that detailed knowledge of the November 1990 sequence of events was required to ensure that similar water hammer events would not occur. The licensee stated they would incorporate the inspector's comments into subsequent revisions to the ESW normal operating procedure, OTN-EF-00001, Revision 11. The licensee also stated that the applicable alarm response procedure would be reviewed and revised as appropriate.

The inspectors reviewed OTN-EF-00001, Revision 11, and identified a caution statement that was worded in such a way that the intent of the caution could be misleading. The caution was used at various steps in the procedure regarding ESW fill and stated in part, "When opening...listen for evidence of water hammering...to determine the throttle position..." As worded, the caution implied that once water hammering was identified; throttle the valve. The intent of the caution was to slowly open the valve to a position to prevent water hammering. If a water hammer then occurred, appropriate actions would be taken (i.e.

throttle the valve). The inspectors concluded that the caution as worded was not safety significant. The licensee took prompt actions and assigned a Central Action Tracking System (CATS) number to this item to revise the wording of the caution in the next procedure revision.

b. Inherent ESW Water Hammer

During the inspection the following two operational events were identified that would result in a water hammer event and the circumstances involved with each:

1. The licensee identified that during a loss of offsite power (LOOP), concurrent with a safety injection (SI) actuation, a water hammer event would result. The water hammer would occur due to water column separation in the ESW system caused by a loss of power to the service water pumps from a LOOP event. A void in the discharge line of the containment coolers would occur caused by the ESW system draining back to the ultimate heat sink during load selection by the loop sequencer. When the ESW pumps restart approximately 35 seconds later as designed, a water hammer event would occur. Based on the ESW system design, this event cannot be prevented procedurally. Currently, the licensee is considering long term corrective actions including modification to containment isolation valves. A review of the licensee's long term corrective actions will be conducted by NRR.
2. During a Station Blackout (SBO) event, a similar water hammer event as described above would occur. An Emergency Operating Procedure (EOP) was identified that specifically addressed the SBO event. However, the inspectors reviewed ECA-0.0, "Loss of All AC Power", Revision 1A0, and identified that the procedure would not prevent a similar water hammer event. ESW water hammer could be avoided if the EOP required system fill and vent prior to resumption of normal system operation. The licensee stated they would review ECA-0.0 and incorporate any appropriate revisions in conjunction with any potential system design changes.

6. Conclusion

The following conclusions were determined after a records review and discussions with the responsible licensee engineers:

- a. The licensee was proactive in their inspection of the RHR system in response to snubber failures at the Wolf Creek facility.
- b. Related water hammer documentation of water hammer events was considered to be adequate.
- c. The licensee walkdowns to identify damaged system components after the water hammer events was considered to be adequate.
- d. The licensee's assessment of the causes of the events was considered to be adequate in view of the specific circumstances, and based on the evidence of damage.
- e. The fill and vent portion of the ESW procedure in place was considered adequate. The procedure required reliance on the plant staff's knowledge of the November 1990 event to preclude a similar occurrence.
- f. A LOOP concurrent with a SI would result in ESW water column separation and subsequent water hammer event. However, a similar water hammer event during a SBO could be procedurally precluded.

The acceptability of the long term fixes for the ESW system will be reviewed and determined by the NRC.

7. Exit Interview

The inspectors met with licensee representatives (denoted in Paragraph 1) at the conclusion of the inspection on September 18, 1992 at the Callaway Nuclear Plant. The inspectors summarized the purpose, scope, and findings of the inspection. The licensee representatives acknowledged this information. The inspectors also discussed the likely informational content of the inspection report with regard to documents reviewed during the inspection. The licensee representatives did not identify any such documents as proprietary.